

LORA BASED WIRELESS SENSOR NETWORK FOR SMART AGRICULTURE

A DISSERTATION

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF
DEGREE

OF

MASTER OF TECHNOLOGY

IN

COMPUTER SCIENCE AND ENGINEERING

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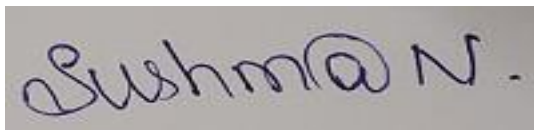
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DECLARATION

I, **Sushma N**, Roll No. **2K18/CSE/16** student of M.Tech (Computer Science & Engineering), hereby declare that the Project Dissertation titled “**LoRa based wireless sensor network for smart agriculture**” which is submitted by me to the Department of Computer Science & Engineering, Delhi Technological University, Delhi. Report of the Major II which is being submitted to Delhi Technological University, Delhi, in partial fulfilment for the requirement of the award of degree of Master of Technology, is original and not copied from any source without proper citation. This work has not previously formed the basis for the award of any Degree, Diploma Associate ship, Fellowship or other similar title or recognition.



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CERTIFICATE

I, hereby certify that the Project Dissertation titled "*LoRa based wireless sensor network for smart agriculture*" which is submitted by Sushma N, Roll No. 2K18/CSE/16, Department of computer Science & Engineering, Delhi Technological University, Delhi in partial fulfilment for the requirement of the award of degree of Master of Technology (Computer Science and Engineering) is a record of a project work carried out by the student under my supervision. To the best of my knowledge this work has not been submitted in part or full for any Degree or Diploma to this University or elsewhere.

Place: Delhi



Dr. Vinod Kumar

Associate Professor

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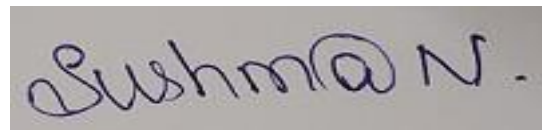
Delhi Technological University

ACKNOWLEDGEMENT

I am most thankful to my family for constantly encouraging me and giving me unconditional support while pursuing this research.

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I also convey my heartfelt gratitude to all the research scholars of the web Research Group at Delhi Technological University, for their valuable suggestions and helpful discussions throughout the course of this research work.

A rectangular box containing a handwritten signature in blue ink that reads "Sushma N.".

Sushma N

Roll-No-2K18/CSE/16

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CHAPTER 1

INTRODUCTION

Our country is agriculture-based nation where half of Indian populace has farming as their primary occupation or side business. Agribusiness is the craftsmanship science or practice for developing harvests by utilizing diverse planning techniques. Ranchers develop the yields utilizing different designed strategies, methods and numerous machines. The customary cultivating rehearses with certain conditions which are subject to the rainstorm or climatic changes. By following the customary strategies proficient outcomes are not watched, we can expand the yield by receiving cutting edge innovations they are additionally called as present day cultivating. Present day cultivating can be accomplished by including new ideas, for example, such Internet of Things (IoT), Wireless Sensor Networks (WSN) and Precision Agriculture (PA). Accuracy agribusiness also known as Precision agriculture is portraying as the condition of workmanship and study of receiving cutting edge innovation to expand the yield development. Horticultural data sources, for example, showering, excrement, bug sprays, and so on are connected in exact amounts as controlled by displaying of yield development courses of action to misrepresent the plant field and to reduce the effect on nature.

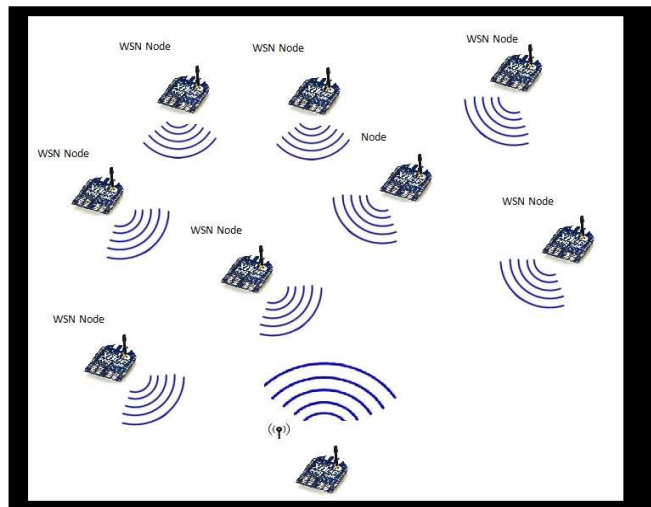


Fig.1. WSN modules.

The assurance of the harvests is basic. So, there is a requirement for checking of the information and that information ought to be genuine. So as to give moment answer for the yields the information ought to be gathered in a savvy way yet not by manual strategies. So, to accomplish this we need to utilize remote sensor organize. As of now wireless sensor network is received by numerous applications like water quality administration, information gathering, wellbeing checking and so on.

The principle goal of this paper is to give quality harvest development method in a predefined standard for example utilizing LoRa innovation. A system contains numerous hubs and every hub will be conveyed in a predetermined and predefined place. In this few hubs, one hub goes about as the organizer that is associated with the concentrated machine. Every hub comprises of a processor for example Arduino, sensors are used for estimating the accompanying parameters such as soil moisture, mugginess, temperature and light power and a LoRa which goes about as the end gadget.

1.1 Introduction to wireless network

Wireless Sensor Network is a rising trend setting innovation that helps the advancement of exactness horticulture. WSN contains sensors, RF modules (radio recurrence modules), microcontrollers to process the information, battery, base station to transmit the information. On going patterns and progressions in WSN innovation have cut the way for the improvement of less expense. Low utilization of intensity and multi-working sensor hubs. Sensor node conveyed at better places detects the diverse natural parameters at that spot and procedure the information as needs be. These sensor hubs can be made to speak with other sensor hubs in the system to trade the fundamental information. The different sensors which are utilized are soil dampness sensor and temperature sensor. There are numerous different sensors like IR sensors, UV sensors, Proximity sensor, LDR sensor, downpour recognizing sensors, stream sensors and so on which are valuable for accuracy horticulture. As India devours 80% of all out accessible water assets for water system reason, we are in a circumstance where water utilization must be diminished utilizing progressed logical procedures to evade this we can utilize soil dampness sensor as an answer. The fundamental attributes of WSN is self-sorting out and self-recuperating. When the hubs are conveyed and a system is shaped at that point, the information will be naturally transmitted with no order or control. On the off chance that any gadget in the system breakdown, at that point the system won't be harmed rather it will take another working way and achieves the goal. So any harms or breaking down of a solitary hub doesn't influence the entire system. With the propelled patterns in WSN, it is workable for us to utilize them in controlling or observing the different ecological parameters for accuracy farming.

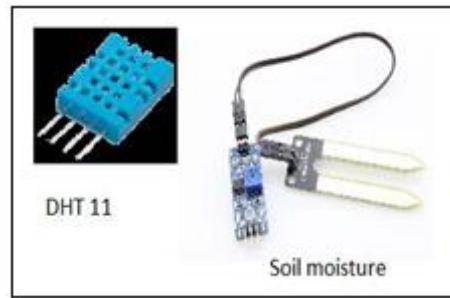


Fig.2. Sensors Used.

Accomplishments of the best in class incorporated advancements give structure and assembling ultralow power transmitters, beneficiaries and sensors, for example every single required component for execution of complex remote sensor systems (WSN) in light of the worldwide Internet of Things (IoT). Relies upon application the design of sensor system can be enormous scale including thousand sensors or little scale dependent on just a few sensors, just as static with fixed topology and area of sensors or dynamic with for all time changing area in space. Genuine applications utilizing IoTbased WSN as principle have half and half design joining diverse remote correspondence innovations. Power utilization and time of independent working for remote sensors are the key elements at planning dependable and maintainable frameworks. PC helped plan of WSN gives enhancement of chose engineering to explicit arrangement of beginning conditions and necessities for the sensible time. Fundamental objective of a WSN manages estimating distinctive physical attributes of the item, for example, temperature, vibration, moistness, radiation, and so on., simple change of got information, for example coding, and send them to a remote host. The gathered informational index can be utilized as crude source for huge information investigation or web based observing of the item conditions.

Advancement in remote correspondence innovations has proposed basic assortment of approaches to interface WSN to the Internet opening the time of IoT. A significant number of such innovations were presented and every one of them have solid and powerless sides. In any case these advancements are utilized giving correspondence in various explicit conditions. The accompanying variables are significant for determination the best possible remote innovation for a applicationexplicit WSN: vitality utilization, information rate, working extent, inactivity, spread factor, recurrence band, cost, and so forth.

These days the IoT applications are normally arranged on the few lowcontrol remote advances and principles. For example, ZigBee as a stage for multibounce work systems and different frameworks dependent on IEEE 802.15.4 standard, which are arranged onto short range correspondence, Bluetooth Low Energy (BLE) giving higher information rate up to 1 Mbps and bigger basic range SIGFOX for execution a system dependent on onejump star topology with inclusion separation up to 50 km and the LoRaWAN as a system engineering with a star-of-

stars topology. In this venture, LoRa gadgets are utilized as both base station and focal station.

LoRa (Long Range) is a protected advanced remote information correspondence innovation. LoRa is a longrun remote correspondence convention that contends with other lowpower widearea network (LPWAN), for example, narrowband IoT (NB IoT) or LTE Cat M1. Contrasted with those, LoRa accomplishes its very long range availability, conceivable 10km+, by exchanging off information rate. This innovation is a rising innovation for the exchange of information in executing sensor organize answers for sensor information accumulation and transmission from end hubs to base stations.

LoRa uses permit free subgigahertz radio recurrence groups like 169 MHz, 433 MHz, 868 MHz (Europe) and 915 MHz (North America). LoRa empowers longextend transmissions (in excess of 10 km in country zones) with low power utilization. The innovation is exhibited in two sections: LoRa, the physical layer and LoRaWAN (Long Range Wide Area Network), the upper layers.

1.2 Introduction to Machine Learning

Machine learning is a service of artificial intelligence (AI) that offers systems to without human intervention learn and get better from experience (knowledge) without being overtly programmed. Machine learning focuses on the growth of computer programs that can right to use statistics data and use it for study or be trained for themselves.

1.3 Machine Learning and Classification

Broadly, there are three types of Machine Learning Algorithms.

- Supervised Learning .the way it works: this set of rules consists of a target / final results variable (or based variable) which is to be expected from a given set of predictors (impartial variables).
- Unsupervised Learning.
- Reinforcement Learning:

Grouping is an utility of information mining that allots questions in an accumulation to board classifications or classes. The objective of classification is to accurately predict the board class for every case in the data. For example, a classification model may possibly be used to classify loan applicants as near to the ground, intermediate, or far above the ground credit risks.

In supervised machine learning observed training sets are available. An algorithm implements classification particularly in a tangible accomplishment is supported or branded as a classifier. In unsupervised machine learning a vast amount of data is given to the program and program will find the patterns and relation between them. Hidden patterns in the data can be discovered by using unsupervised machine learning technique.

Machine learning brings computer science and statistics together to improve the prediction power. Data scientists, data analysts uses the machine learning and also who wants to use the raw data to predict or find trends in data. In agriculture there will be vast amount of data and also it increases day by day, in order to find the accurate prediction of crop prediction machine learning techniques can be used.

1.4 Precision Agriculture

Precision farming means its a administration technique that increases efficiency and financial comes back with a reduced impact on the environment. Precision farming is based on the utilization of data innovation to a portrayal of inconstancy in the field, variable-rate tasks and the basic leadership framework. Precision farming development includes three technology levels and three strategies. It utilizes a constant spectrophotometer and was created to depict soil fluctuation in ranchers' fields.

In order to balance productivity with environmental concerns, precision farming provides a new solution using systems approach. Precision farming is based on propelled data innovation. Coordinating rural practices to meet site-particular prerequisites, depicting and displaying variety in soils and plant species are additionally incorporated into precision farming. The primary point of accuracy cultivating is to increment monetary returns and at decreasing the vitality input and the natural effect of farming.

CHAPTER 2

LITERATURE SURVEY

[1] G. Sahitya, N. Balaji and C. D. Naidu, "Wireless sensor network for smart agriculture," 2016 2nd International Conference on Applied and Theoretical Computing and Communication Technology, Bangalore, 2016, pp. 488-493.

Presently developing yields are turning into an extremely tumultuous errand for the ranchers on account of the capricious atmosphere and cost of the seeds. Due to the eccentric and abrupt difference in the atmosphere the harm proportion will be high and even the misfortune rate will be high. So as to beat this situation we need to receive a plan methodology which ought to be viable. The answer for this issue is by following the procedures of exactness agrribusiness otherwise called savvy horticulture. Accuracy Agriculture is a procedure of giving a right arrangement of contributions to the harvests or terrains as indicated by the earth changes. Exactness Agriculture pursues a characterized set of principles. They are gathering the information, preparing the information, sending the information to the incorporated machine and as indicated by the information got the choices will be taken by the master

[2] M. Saari, A. M. bin Baharudin, P. Sillberg, S. Hyrynsalmi and W. Yan, "LoRa — A survey of recent research trends," 2018 41st International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO), Opatija, 2018, pp. 0872-0877.

Wireless Sensor Networks (WSN) have created at a quick pace as of late and have additionally been one of the major focal points of research in remote innovation. This fast advancement has been encouraged by the advancement of gadgets scaling down, development in execution, remote innovations, vitality proficiency, and the improvement of conventions. The sensors that gather natural data from the environment have been scaled down gratitude to the quick execution, enhancement, and scaling down innovation of the equipment. The improvements of new remote correspondence advancements and falling costs have empowered fresh out of the plastic new uses for remote sensor organize gadgets.

[3] O. Tamoghna, M. Sudip, R. N. Singh, "Wireless sensor networks for agriculture: The state-of-the-art in practice and future challenges," Ad Hoc Net., Vol.4, pp.669-686, November 2006.

The emergence of Wireless Sensor Networks (WSNs) impelled another heading of research in horticultural and cultivating space. As of late, WSNs are broadly connected in different rural applications. The potential WSN applications are checked on, and the particular issues and difficulties related with conveying WSNs for improved cultivating. To concentrate on the particular prerequisites, the gadgets, sensors and correspondence strategies related wi

th WSNs in rural applications are dissected exhaustively.

[4] A. Augustin, J. Yi, T. Clausen, W. M. Townsley, "A Study of LoRa: Long Range & Low Power Networks for the Internet of Things," Sensors (Switzerland), Vol.16, pp.1-18, September 2016.

LoRa is a long-run, low-control, low-bitrate, remote media communications framework, advanced as a foundation answer for the Internet of Things: endgadgets use LoRa over a solitary remote bounce to convey to gateway(s), associated with the Internet and which go about as straightforward extensions and transfer messages between these end-gadgets and a focal system server.

[5] O. Georgiou U. Raza "Low Power Wide Area Network Analysis: Can LoRa Scale?" IEEE Wireless Communications Letters vol. 6 no. 2 pp. 162-165 2017.

Low Power Wide Area (LPWA) systems are gaining staggering ground from plan, institutionalization, to commercialisation. During this season of quick paced appropriation, it is of most extreme significance to dissect how well these advances will scale as the quantity of gadgets associated with the Internet of Things (IoT) unavoidably develops.

The most recent years have seen much enthusiasm for Low Power Wide Area (LPWA) advances, which are increasing extraordinary force and business enthusiasm towards the acknowledgment of the Internet of Things (IoT). There are numerous competitors that have hocked the exploration network, effectively seeking after institutionalization, appropriation, and business organizations in parallel.

[6] U. Raza, P. Kulkarni, and M. Sooriyabandara, "Low Power Wide Area Networks: A Survey," arXiv preprint arXiv:1606.07360, 2016.

Most LPWA systems work in the unlicensed ISM groups at 169, 433, 868/915 MHz, and 2.4 GHz relying upon the locale of activity. The absolute most articulated LPWA applicants are SigFox, LoRa, Weightless, and Ingenu.

[7] G. Margelis, R. Piechocki, D. Kaleshi, and P. Thomas, "Low throughput networks for the IoT: Lessons learned from industrial implementations," in Internet of Things (WF-IoT), 2015 IEEE 2nd World Forum on, pp. 181–186, IEEE, 2015.

The emphasis is on LoRa (Long Range), a standout amongst the most encouraging widezone IoT advances proposed by Semtech and further advanced by the LoRa Alliance. At the core

of LoRa's prosperity is its versatile information rate twitter balance innovation taking into account adaptable long-extend correspondence with low power utilization and ease plan. Basically, this is accomplished by means of spread range various access procedures pleasing numerous clients in a single channel.

[8] L. Vangelista, A. Zanella, and M. Zorzi, "Long-Range IoT Technologies: The Dawn of LoRa," in Future Access Enablers of Ubiquitous and Intelligent Infrastructures, pp. 51–58, Springer, 2015.

LoRa Alliance has characterized the higher layers and system design on top the LoRa physical layers and named them LoRaWAN. Together, these highlights make LoRa appealing to engineers who can construct total framework arrangements over it for both geological and private/mechanical kinds of IoT systems, in this manner optimizing its market selection. Regardless of this achievement, LoRa has not yet pulled in comparative dimensions of consideration from the scholarly and look into network with without a doubt, not very many friend assessed concentrates distributed to date.

Title: Yield Recommendation System for Precision Agriculture.

Year Of Publication: January,2016

Author Name: S.Pudumalar, E.Ramanujam

Journal: IEEE Transaction

In this paper the discourse is done with respect to the prerequisites and arranging required for building up a product display for accuracy cultivating. The author gives the rudiments of precision farming and move towards building up a model. It portrays the accuracy horticulture standards to little, open ranches at the individual rancher and product level. It likewise influence the level of control over changeability. To convey guide warning administrations to even the littlest rancher at the level of his/her littlest plot of harvest, utilizing the most available innovations, for example, SMS and email are the principle destinations. In Kerala State where the normal holding size is much lower than the vast majority of India and this model has been intended for this situation.

Title: 2 Study of order calculations for detailing yield forecast exactness in accuracy agribusiness

Author Name: Saiyyad Mohmmad Ali Muzffar Ali.

Year Of Publication: February 2018

Journal: International Journal of Advanced Research in Computer Engineering & Technology (IJARCET)

Agriculture planning plays an important role in any country. Agriculture sector provides various outputs such as food, raw material for industry, economical boost and employment. The agriculture sector contains vast data with respect to factors affecting its input and output. With advances in technology various data mining techniques are introduced. These data mining techniques can be used to analyze the multidimensional, time specific data of agriculture sector to produce effective knowledge from it which can be used to boost the economy. In this paper we survey various approaches used by different researcher to deal with analysis of agriculture sector to provide effective way to increase production and effective use of resources which in turn increases the economy in this sector.

CHAPTER 3

SOFTWARE REQUIREMENTS SPECIFICATION

3.1 Software and Hardware Requirements

Hardware Specification

Processor	-Pentium III or Higher
RAM	- 2GB or Higher
Hard disk	- 500 GB
Sensors	- Soil moisture, DHT 11,Ph sensor
LoRa transmitter	
LoRa receiver	
ESP32 kit	
Bread board	
Jumper wires	

Software Specification

Front end	- Bootstrap Framework
Programming Language	- PHP, C
Operating System	- Windows 7 or Any Compatible
Editor	- Notepad++
IDE	- Arduino
Server	- Apache web server

3.2 Functional Requirements

Following are the functional entities observed in the project:

Sensors

Are the electronic gadgets which sense the soil damoness content, temperature and humidity of air and send them to base station.

Esp32 Kit

This kit fetches the values form sensors and converts the analog data to digital; these inform ation gets prepared utilizing C language and is transferred to server utilizing Wi-Fi arranged system.

Breadboard

This gadget interfaces different parts and structure circuit without soldering, it has framework of interconnected attachments with which we can associate different segments required for task.

Wi-Fi network

Information gathered from sensors should be transferred to remote server; it is finished utilizing a Wi-Fi network, it is required to make reference to SSID and secret key of the Wi-Fi arrange in the code to build up correspondence.

Lora Transceivers

LoRa is a remote information correspondence innovation that uses a radio tweak procedure that can be produced by Semtech LoRa handset chips. This adjustment system permits long range correspondence of limited quantities of information (which means a low data transmission), high invulnerability to obstruction, while limiting force utilization. In this way, it permits long separation correspondence with low power necessities.

LoRa utilizes unlicensed frequencies that are accessible around the world. These are the most broadly utilized frequencies:

868 MHz for Europe

915 MHz for North America

433 MHz band for Asia

3.3 Non - Functional Requirements

Non-

Functional necessities in light of the fact that the name recommends, region unit those necessities that indirectly included with the specific capacities created to the framework. They will identify with the incipient framework properties such constancy, response time and furthermore the capacity tenure. Numerous utilitarian necessities identify with the technique and entire as opposed to individual useful prerequisite may corrupt the framework; inability to meet a non-practical framework prerequisite may take framework unusable.

The non-functional requirements are:

Security

LoRa handset modules tune in to bundles inside its range. It doesn't make a difference where the parcels originate from. To guarantee you just get parcels from your sender, you can set a match up word (ranges from 0 to 0xFF).

LoRa.setSyncWord(0xF3);

Both the recipient and the sender need to utilize the equivalent adjust word. Along these lines, the recipient disregards any LoRa parcels that don't contain that adjust word.

Constraints

Since LoRa gadgets work in the free permit band offered by the Government of concerned area we should ensure gadget works in permitted band.

Reliability

Framework works fine under ordinary conditions, as for time when temperature builds unit g et warmed and neglects to execute as proposed.

CHAPTER 4

SYSTEM DESIGN AND ARCHITECTURE

4.1 SYSTEM PERSPECTIVE

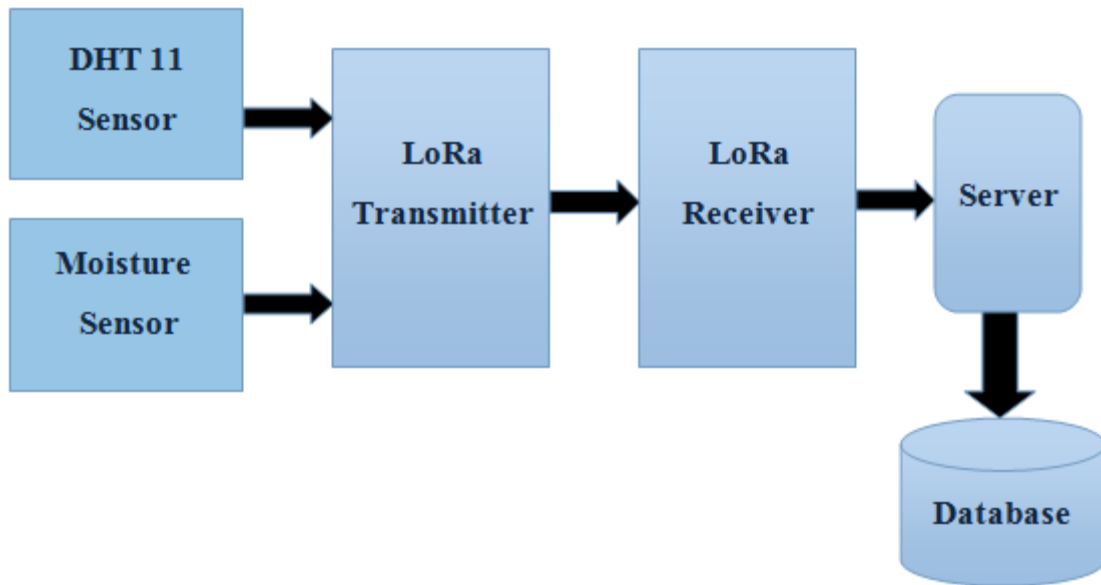


Fig 5 - Architecture diagram

Description: The Fig 5 shows the architecture diagram, DHT11 sensor fetches the temperature and humidity values, soil moisture sensor gives the moisture value of soil, these are given to the LoRa sender. This in turn sends the data to LoRa receiver without the help of any network. LoRa devices create a wireless data communication network. Further, a server can be used to dump the data into the database.

4.2 CONTEXT DIAGRAM

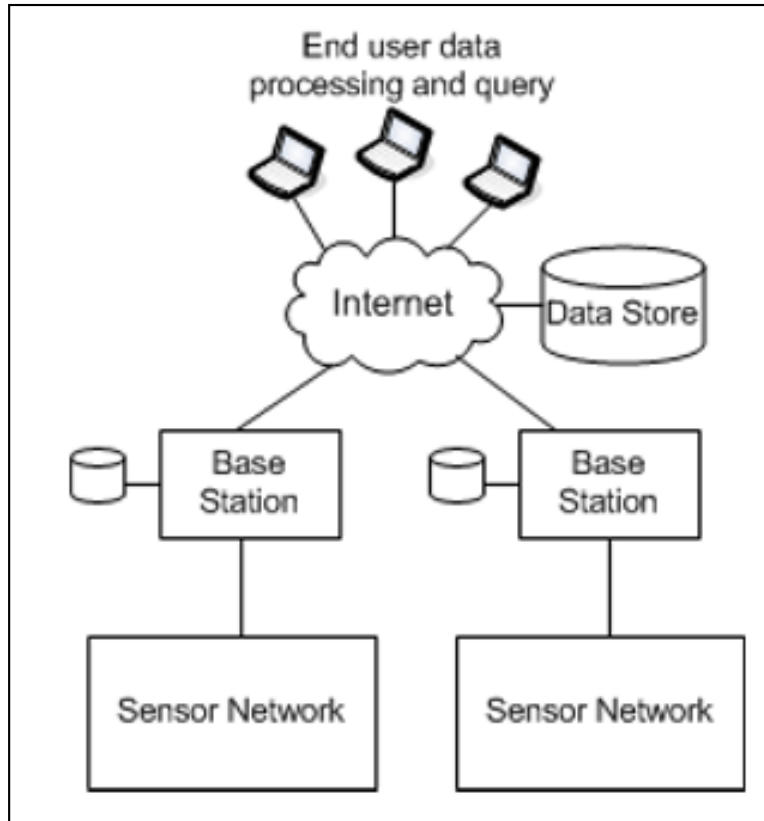
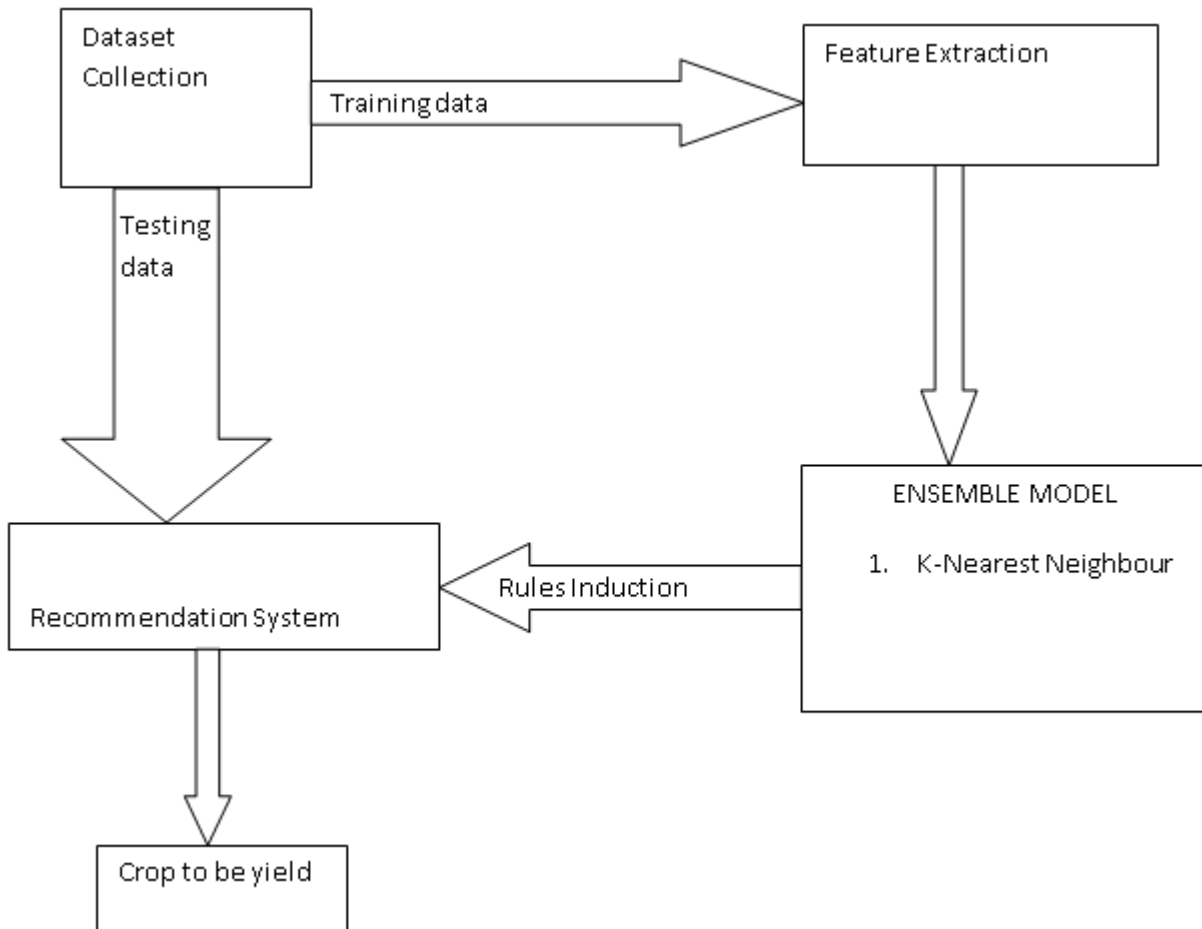


Fig 6 - Context diagram

Description: The Fig 6 describes the end user data which process to the base station and sensor network for the data storage through the internet as a medium and which indicates the data fetched by the sensors to the perspectives users.

4.3 Block diagram of crop recommendation system



The following guidelines were taken into account while designing the application:

- A design should exhibit hierarchical organization that makes the intelligent use of control among components of the software.
- A design should be modular i.e. the software should be logically partitioned into components that perform specific function and sub function.
- A design should lead no interfaces that reduce the complexity of connections between and modules with the external environment.

4.4 SEQUENCE DIAGRAM

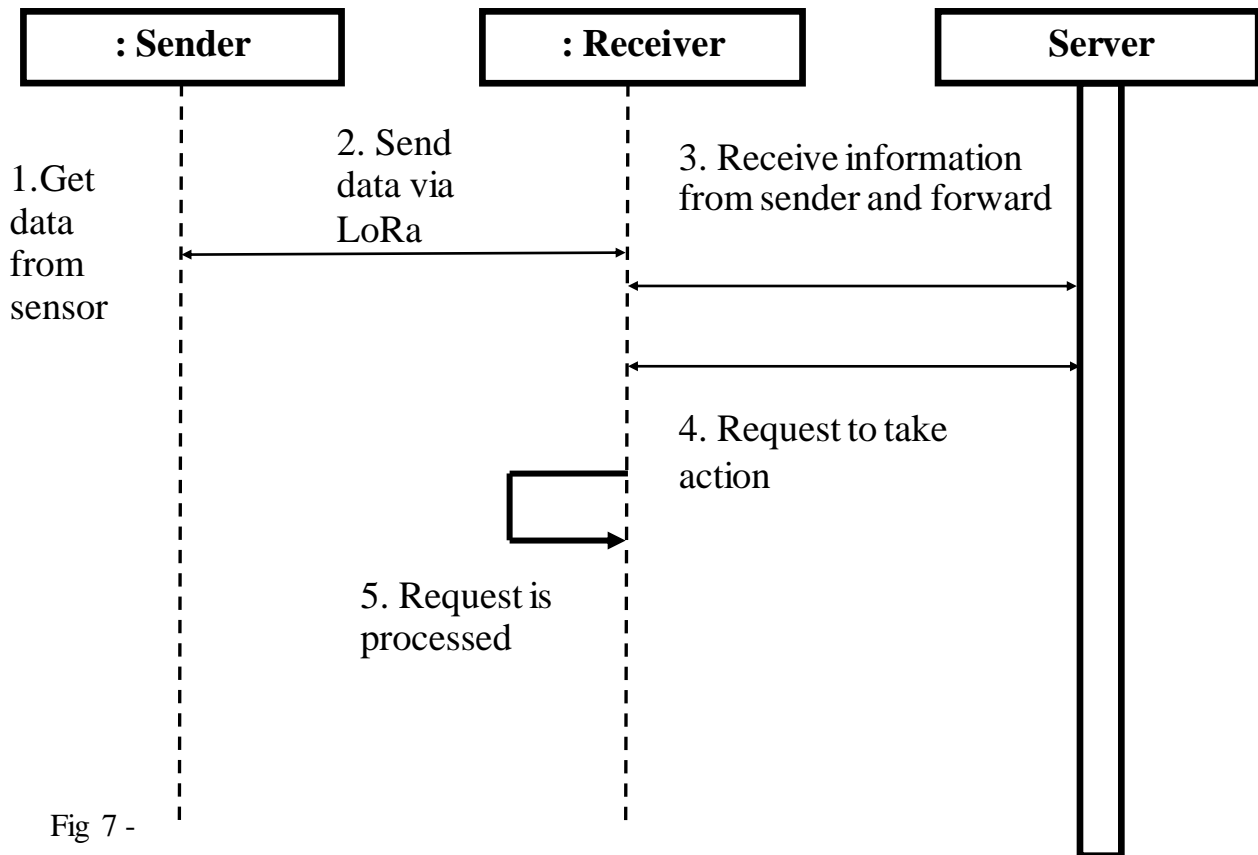


Fig 7 -

Sequence diagram

Description: This diagram shows the interactions of sender, receiver and server arranged in time sequence. The parallel vertical lines are the lifelines, horizontal arrows indicate the exchanged messages. The sequence flow of data from sender to receiver and also to that of server is described here.

4.5 DATAFLOW DIAGRAM

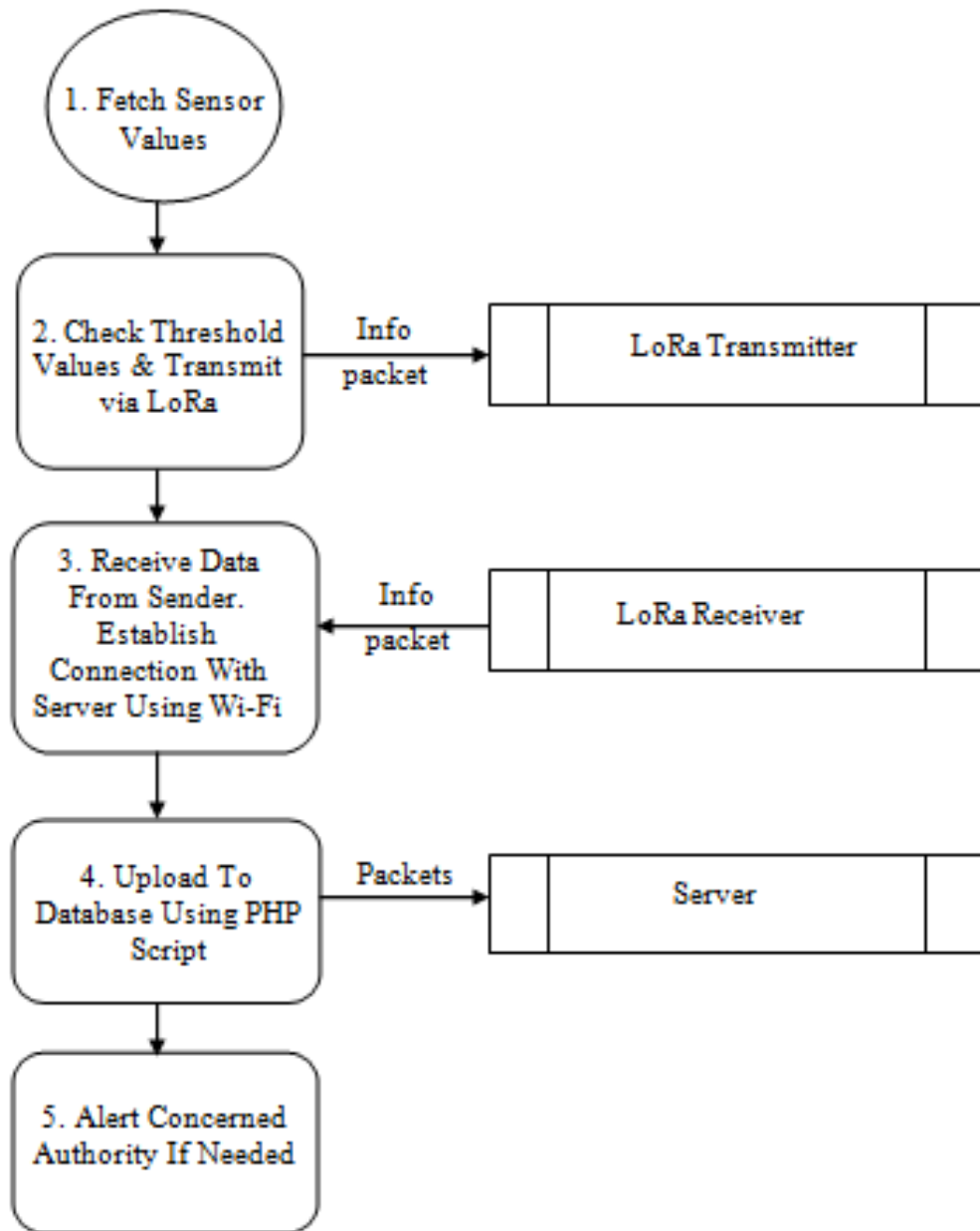


Fig 8 - Dataflow diagram

Description: The Fig 8 describes the flow of data between LoRa transmitter, LoRa receiver and the server. The data is fetched from the sensors, given to sender, which wireless transmits it to the receiver. Through Wi-Fi the data is sent to a server which dumps it all into a database.

4.6 ACTIVITY DIAGRAM

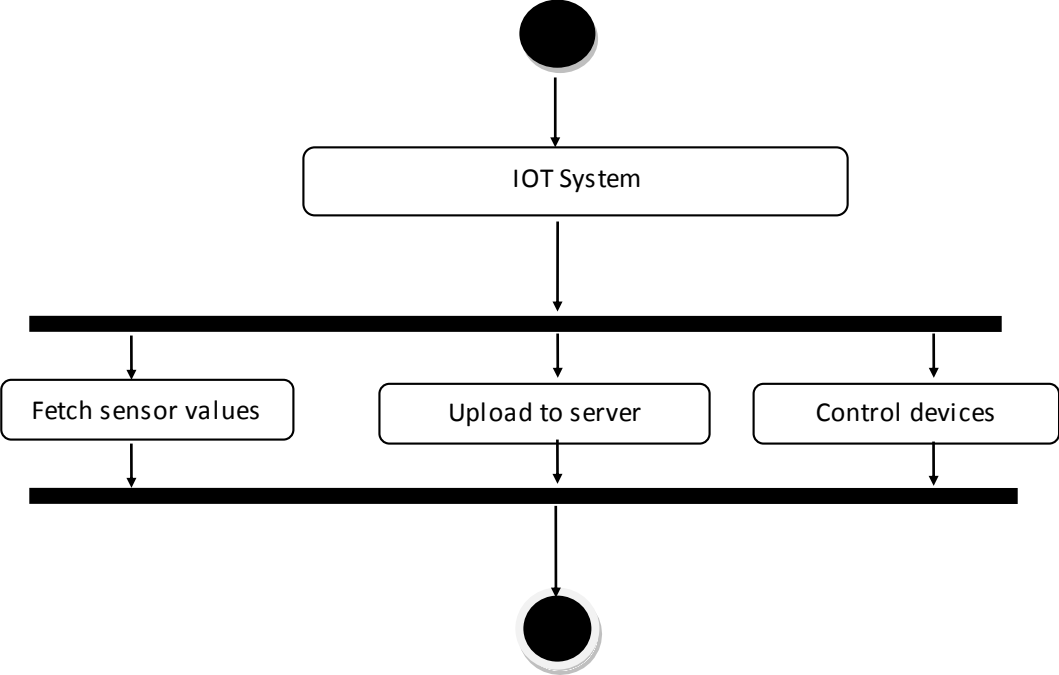
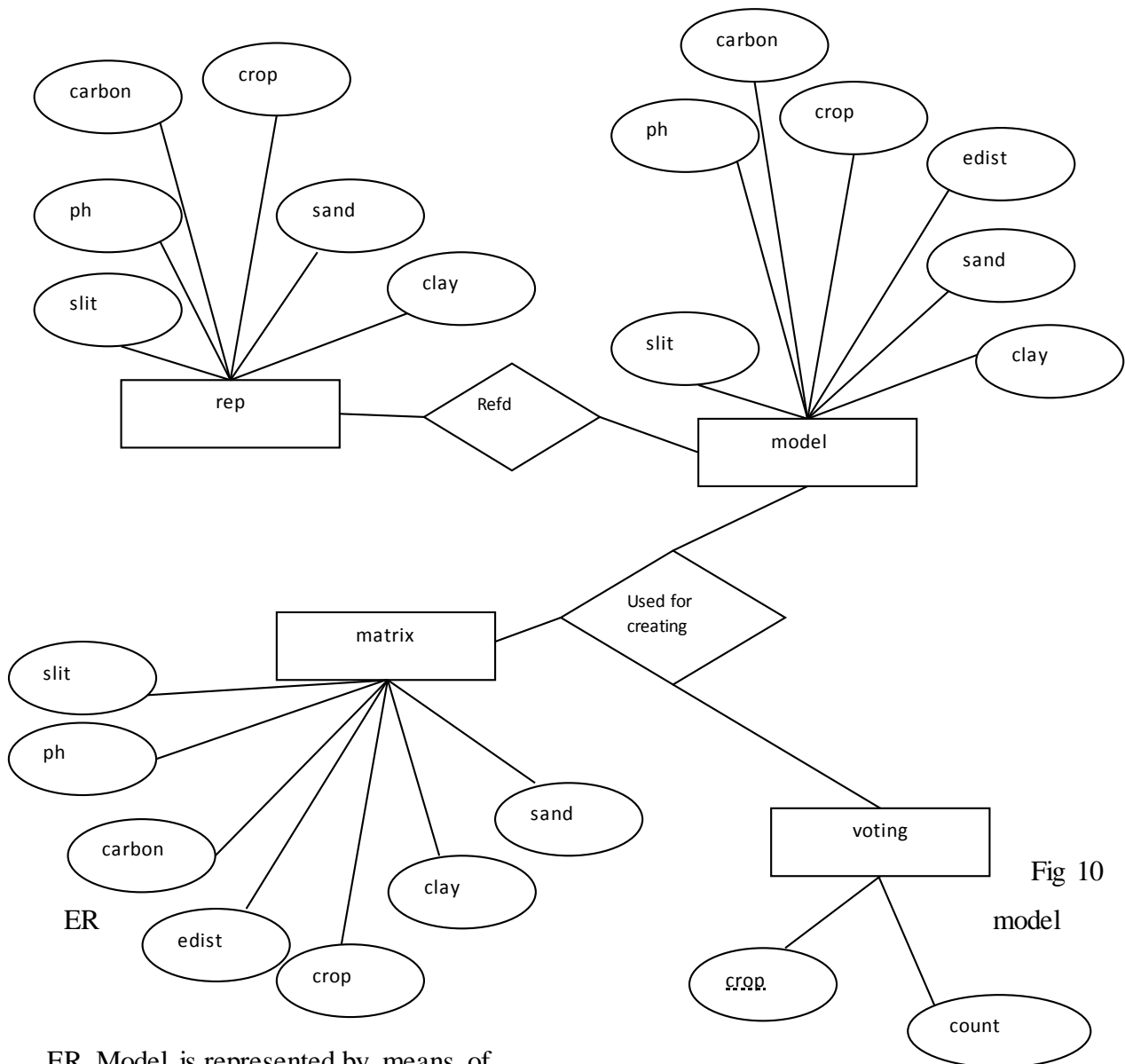


Fig 9 - Activity diagram

Description : The Fig 9 describes the data fetch from the moisture,Ph sensor as well as DHT11 sensor, these are uploaded to a server and depending on the values the devices are controlled.

4.6 DATABASE DESIGN

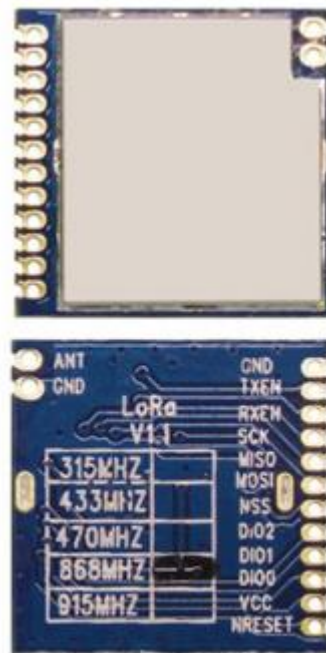


ER Model is represented by means of

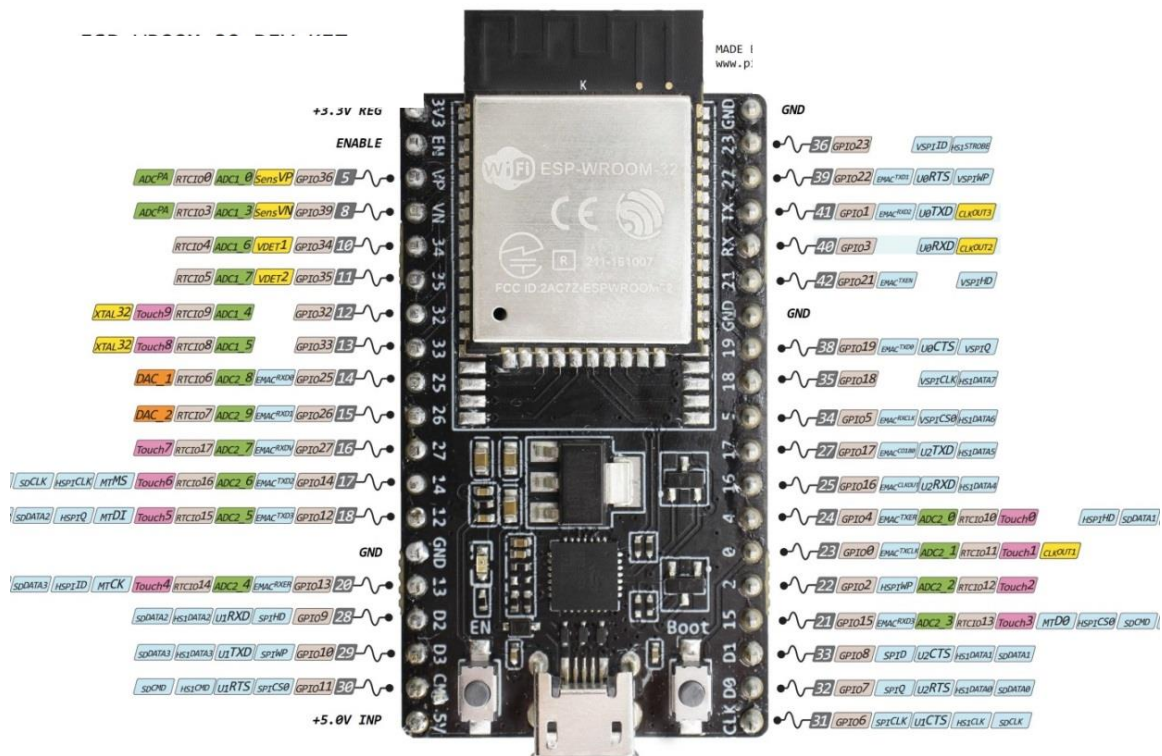
an ER diagram. Any object, for example, entities attributes of an entity, relationship sets, and attributes of relationship sets, can be represented with the help of an ER diagram.

In this ER diagram it consists of four entities such as rep, model, matrix, voting each entities are represented by rectangles. The properties of entities is called Attributes. Attributes are represented by means of ellipses. Here PH, Carbon, Slit, Sand, Clay represents the attributes and they are directly connected to the entities. Diamond-shaped box represents relationships. Inside the diamond-box the name of the relation has been written. All the entities participating in a relationship, are connected to it by a line.

4.7 PIN CONFIGURATION OF LORA WIRELESS TRANSCIEVERS



4.8 PIN CONFIGURATION OF ESP- WROOM - 32 DEV MODULE



CHAPTER 5

ALGORITHM

5.1 Algorithm for Arduino Code

Step1: Configuring the soil moisture sensor for reading values

Soil moisture sensor will have 3 pins, VCC, GND and OUT, connect VCC to 3.5V, GND to ground and OUT pin to IO pin of ESP32. And turn on the kit, following steps should be followed to read the values.

Function ReadMoisture()

Begin

Value=ReadValues(pin number)

SendToTransmitter(value)

IntroduceDelay()

End of function

A function needs to be defined for reading values of moisture sensor with an average delay of 1 or 2 seconds. The read value must be sent to transmitter of base station for further transmission.

Step2: Configuring the temperature/Humidity sensor for reading values

DHT11 (Temperature and Humidity) Sensor will have 4 pins, VCC, DATA,NC,GND, connect vcc to 3.5 v,GND to ground and data pin to IO pin of ESP32. And turn on the kit, following steps should be followed to read the values.

Function ReadTemperatureandHumidity()

Begin

1. **int** readData = DHT.read22(dataPin); // Reads the data from the sensor
2. **float** t = DHT.temperature; // Gets the values of the temperature
3. **float** h = DHT.humidity; // Gets the values of th

SendToTransmitter(value)

IntroduceDelay()

End of function

A function needs to be defined for reading values of humidity and temperature sensor with an average delay of 1 or 2 seconds. The read value must be sent to transmitter of base station for further transmission.

Step3: Configuring Lora Sender Device

Include the required library

```
#include <SPI.h>
#include <LoRa.h>
```

Then, define the pins used by your LoRa module

```
#define ss 5
#define rst 14
#define dio0 2
```

initialize a serial communication.

```
Serial.begin(115200);
while (!Serial);
```

Set the pins for the LoRa module.
LoRa.setPins(ss, rst, dio0);

And initialize the transceiver module with a specified frequency.

```
while (!LoRa.begin(866E6)) {
  Serial.println(". ");
  delay(500);
}
```

initialize a packet with the *beginPacket()* method.

```
LoRa.beginPacket();
write data into the packet using the print() method
```

```
LoRa.print("hello ");
LoRa.print(counter);
```

close the packet with the *endPacket()* method

```
LoRa.endPacket();
```

Introduce delay for next transfer

```
delay(10000);
```

Step4: Configuring Lora Receiver

To read the incoming data you use the *readString()* method.

```
while (LoRa.available()) {  
  String LoRaData = LoRa.readString();  
  Serial.print(LoRaData);  
}
```

Finally, the next statement print the received packet in dB.

```
Serial.println(LoRa.packetRssi());
```

5.2 Algorithm of ESP32 Code

Step 1:

Launch Arduino IDE

Step2:

Include all necessary header files

Step 3:

Get Blynk authentication key.

Define Wi-Fi SSID and password

Step 4:

Within setup `WiFi.begin(ssid, password)` method initialize Wi-Fi connection using `WiFi_Adapter` method, ensure Wi-Fi connection is successful.

Initiate blynk routine.

Step 5:

Read sensor data from `pin 35` of ESP32, `define` this task in loop method as this method gets called repeatedly.

Step 6:

Using Wi-Fi Client method send sensor data to PHP script hosted at local apache server, use hotspot IP for this purpose.

Step 7:

Close connection.

5.3 Algorithm of Android app code

Step1:

Launch Android studio

Step2:

Using layout.xml file put web view and button view components, add id attributes to both components

Step3:

Define web view and button view objects in mainactivity.java code, refer xml objects with java objects using findViewById() method.

Step4:

Enable JavaScript option of web view to true, and load the php script named loadsensordata.php from locally hosted server to web view using loadURL() method.

Step5:

Launch Blynk app for click event of the button using Intent.

5.4 Database connection Algorithm

Step 1:

Call the function to establish connection with data base

```
$conn=mysqli_connect ('hostname','username','password','database name');
```

Step 2:

Make sure connection is successful, if not terminate the program

```
If( not $conn )  
{  
    Exit from function  
}
```

Step 3:

Prepare the sql statement and run the query

```
$sql=select column names from table name [where condition]
```

```
$res=$conn->query ( $sql )
```

Step 4:

Make sure the transaction is successful, if so return the value otherwise terminate the program.

```
If( not $res )
{
Exit from function
}
Else
Return $res
```

Step 5:

Exit from the function

5.4 KNN Algorithm

Algorithm Steps:

1) Training algorithm:

For each training example $(x, f(x))$, add the example to the list training examples.

2) Classification algorithm:

- Given a query instant x_q to be classified as
 - Let $x_1 \dots x_k$ denote the k instances from training examples that are nearest to x_q .
 - Return

$$\sqrt{\sum_{i=1}^n (q_i - p_i)^2}$$

In this work the experiments are performed on two important and well known classification algorithms K-Nearest Neighbor (KNN) and Naive Bayes (NB) are applied to the soil dataset which is taken from the soil testing laboratory. By evaluating the datasets accuracy is obtained. A process view analyses are configured and it has a comfortable user interfaces. Respective operators are used in the analysis process where in it uses a modular concept. The operators can communicate with the other operators with the help of input and output ports. Based on the outcome of the K

neighbors closest to that point K-Nearest Neighbor makes predictions. In order to define a metric for measuring the distance between the query point and cases from the examples sample KNN make predictions. Euclidean distance is used to measure the distance between query points.

$$D(x, p) = \sqrt{x - p^2}$$

By introducing a set of weights W (2), one for each nearest neighbor, defined by the relative closeness of each neighbor with respect to the query point this can be achieved.

$$W(x, p) = \frac{\exp(-D(x, p_i))}{\sum_{i=1}^k \exp(-D(x, p_i))}$$

Where $D(x, p_i)$ is the distance between the query point x and the i th case p_i of the example sample.

$$\sum_{i=1}^k W(x, p_i) = 1$$

Thus, the maximum of y is taken for each class variables, for classification problems is as shown:

$$\max (y = \sum_{i=1}^k W(x, p_i) y_i)$$

Implementation:

- 1) Load the data.
- 2) Initialize the value of k .
- 3) For getting the predicted crop, iterate from 1 to total number of training data points.
- 4) Calculate the distance between test data and each row of training data. Here we will use Euclidean distance as our distance metric since it's the most popular method.
- 5) Based on distance values Sort the calculated distances in ascending order
- 6) Get top k rows from the sorted array.
- 7) Get the most frequent crop of these rows.
- 8) Return the predicted crop.

Example:

In this work soil parameters that are considered are PH, Carbon, sand, slit and clay. Training data consists of 324 records which are collected and tested in soil testing lab. Testing data is the data that is directly fetched from the soil grid based on latitude and longitude values. Consider testing data for given latitude longitude values are as follows.

Testing data: Data fetched from soil grid

PH	Carbon	Sand	Slit	Clay
6.4	0.7	51	24	26

For $k = 3$

Matrix table:

$$D(p,q) = d(q,p) = \sqrt{(q_1-p_1)^2 + (q_2-p_2)^2 + \dots + (q_n-p_n)^2}$$

$$= \sqrt{\sum_{i=1}^n (q_i-p_i)^2}$$

$$= \sqrt{(6.4-5.82)^2 + (0.7-0.88)^2 + (51-53)^2 + (24-25)^2 + (26-23)^2}$$

$$= 3.061$$

PH	Carbon	Sand	Slit	Clay	Distance	Crops
5.82	0.88	53	25	23	3.061	Corn
s5.82	0.88	53	25	23	3.061	Corn
6.41	1.58	53	25	23	3.126	Rice

Since K value is 3 it searches the nearest neighbor for the data fetched from the soil grid to the previously uploaded data in the database. It calculates the distance by using Euclidean distance and selects the crop having minimum distance.

Voting Table:

Crops	Count
-------	-------

Corn	2
Rice	1

Since corn has highest voting the recommended crop will be **corn**

CHAPTER 6

IMPLEMENTATION

6.1 Coding used in the project

6.1.1 Sender code of Lora Transmitter

```
#include<dummy.h>

#include <WiFi.h>

#include<WiFiMulti.h>

#include <WiFiClient.h>

#include <BlynkSimpleEsp32.h>

#include <SPI.h>

#include <LoRa.h>

#include <DHT.h>
```

Above statements i.e. #includes are known as pre-processor directives they will have prototype of the functions and/or definitions of class. Based on the task or purpose they will have been created, name of the file itself indicates the purpose they have been created for. In this project we are going to use above header files for various tasks such as creating Wi-Fi access point, sending client request to remote server, initializing Lora devices, reading values from DHT11 sensor etc.

```
#define BLYNK_PRINT Serial;

#define DHTTYPE DHT11 // DHT 11

#define ss 5

#define rst 14

#define dio0 2
```

Like “#include” statements “#define” statements are also known as pre-processor statements, but these statements have been used to create symbolic constants so that users could easily remember the symbols than values. For example #define pi 3.142 statement creates a symbolic constant called pi with the value 3.142. Instead of writing value 3.142 in the code we write pi and it get replaced with value before compilation.

```

WiFiMulti WiFiMulti;

int counter = 0;

int value= 0;

char auth[] = "4ad96f9acf498f895e64f24ad4b080";

const char* ssid = "JioFi4_TallOak";

const char* pass = "1jv0d3d71i"; //Your Wi-Fi password

const char* host="192.168.225.44";

float h,t;

```

Above statements are called declaration or initialization statements, this section includes declaration of variables and or assigning values to them. In this project we have declared variables such as authentication as auth with value auth key being obtained from blynk server,ssid having value name of Wi-Fi ssid, password with value of Wi-Fi password etc.

```

void connect_to_wifi()
{
WiFiMulti.addAP(ssid,pass);

Serial.print("wait for wifi..");

while( WiFiMulti.run() != WL_CONNECTED )
{
Serial.print(".");

delay(500);

}

Serial.print("Connected");

}

```

Above function is user defined function used in this project to establish connection with the Wi-Fi network through ssid and password, initially it create an Access point by calling addAP() function, connection process is initiated by calling run() method , since connection procedure takes time it is called in while loop with delay of 500 mili seconds loops keeps on trying to connect with network, once connection is successful it exits from the loop.

This function is called from setup() function so that connection is established in advance before invoking loop() function which executes repeatedly to send sensor data.

```

Void setup() {

//initialize Serial Monitor

Serial.begin(115200);

```

```

while (!Serial);

Serial.println("LoRa Sender");

//setup LoRa transceiver module
LoRa.setPins(ss, rst, dio0);

//replace the LoRa.begin(--E-) argument with your location's frequency

//433E6 for Asia

//866E6 for Europe

//915E6 for North America

while (!LoRa.begin(433E6)) {

Serial.println(".");

delay(500); }

LoRa.setSyncWord(0xF3);

Serial.println("LoRa Initializing OK!");

connect_to_wifi();

Blynk.begin(auth, ssid, pass);

}

```

The method `setup ()` gets called only once during execution of the program before calling `loop()`, as its name indicates this method is used for setting up the basic environment required to start the working of the prototype. In this project the tasks such as initializing the serial monitor, setting up the Lora pins, assigning sync word to Lora packets for security purpose, invoking blynk application, establishing connection with Wi-Fi network are done.

```

void loop() {

Serial.print("\n Sending packet: ");

Serial.println(counter);

//Send LoRa packet to receiver

LoRa.beginPacket();

//LoRa.print("hello ");

LoRa.print(counter);

//Serial.println(counter);

value = analogRead(34);

LoRa.print("sensor value="+String(value));

Serial.println(value);

delay(2000);

LoRa.endPacket();

cunter++;
}

```

```

    Blynk.run();
    Send_Data();
}

```

loop() is a method or function which gets called repeatedly when sketch is loaded to device, most useful tasks the device supposed to do are written in this function , to track the behaviour of the code we will use serial monitor as a log file, response of the code is displayed to serial monitor periodically. The tasks such as reading sensor data, normalizing the data, activating the various pins of the associated devices, creating and sending Lora packets , sending read information to server using send_data() function etc. are done in this method.

```

    void Send_Data()
    {
        WiFiClient client;
        if (!client.connect(host, 80)) {
            Serial.println("connection failed");
            return;
        }
        String url="http://192.168.225.44:80/d/add.php?temp="+String(value);
        Serial.print("Requesting URL: ");
        Serial.println(url);
        // This will send the request to the server
        client.print(String("GET ") + url + " HTTP/1.1\r\n" +
            "Host: " + host + "\r\n" +
            "Connection: close\r\n\r\n");
        unsigned long timeout = millis();
        while (client.available() == 0) {
            if (millis() - timeout > 5000) {
                Serial.println(">>> Client Timeout !");
                client.stop();
                return;
            }
        }
        // Read all the lines of the reply from server and print them to Serial
        while(client.available()){
            String line = client.readStringUntil('\r');
            Serial.print(line);
        }
    }
}

```

```

Serial.println();

Serial.println("closing connection");

}

```

The above code being written for the Lora transmitter module, in this module task has been divided among four functions such as void setup(),void loop(), void connect_wifi(),void senddata(), function setup() will be used to initialize the components and pin modes of the device, connect_wifi() function connects esp32 device with the pre-configured SSID and password of the Wi-Fi network, function loop read the data such as temperature, humidity, moisture from DHT11 and voltage, current sensor and send information via Lora transmitter at 433MHZ to receiver

6.1.2 Receiver code of Lora

```

#include <SPI.h>

#include <LoRa.h>

//define the pins used by the transceiver module

#define ss 5

#define rst 14

#define dio0 2

void setup() {

  Serial.begin(115200);

  while (!Serial);

  Serial.println("LoRa Receiver");

  //setup LoRa transceiver module

  LoRa.setPins(ss, rst, dio0);

  while (!LoRa.begin(433E6)) {

    Serial.println(".");

    delay(500);

  }

  LoRa.setSyncWord(0xF3);

  Serial.println("LoRa Initializing OK!");

}

void loop() {

  // try to parse packet

  int packetSize = LoRa.parsePacket();

  if (packetSize) {

    // received a packet

    Serial.print("Received packet ");

    // read packet

    while (LoRa.available()) {

```

```

String LoRaData = LoRa.readString();

Serial.print(LoRaData);

// print RSSI of packet

Serial.print(" with RSSI ");

Serial.println(LoRa.packetRssi());

}}

```

The receiver code works similar to sender by invoking series of methods such as setup (), loop(). The information packets being sent from Lora sender will have unique syncword, same synch word needs to be used at receiver to identify the packets being sent from own transmitter, the concept of synch

6.1.3 Program for Android Application

In this code we have used a widget called web view using this object it is possible to load a remote web page into android app, in this project sensor data is dumped to a centralized database using ESP32 Wi-Fi module, the data present in the table is fetched using PHP scripting file called readdata.php, this file is loaded to web view to display status of the field to farmer. Soon after tapping the app an http request is sent to apache webserver hosted locally, for this we are using IP address of the hotspot. Response of the file is loaded to web view and displayed at end users side.

Along with web view there is button provided to launch the Blynk app with which motor can be turned on or off.

Mainactivity.java

```

package app.nomitha.com.webview;

import android.content.Intent;
import android.net.Uri;
import android.support.v7.app.AppCompatActivity;
import android.os.Bundle;
import android.view.View;
import android.webkit.WebView;
import android.widget.Button;

public class MainActivity extends AppCompatActivity {

    WebView mywebview;
    Button b1;

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_main);

        b1=findViewById(R.id.button);

        mywebview=(WebView)findViewById(R.id.mywebview);

        mywebview.loadUrl("http://192.168.43.84/d/readings.php");
    }
}

```

```

    mywebview.setWebViewClient(new MyWebViewClient());
}

    public void launch( View v)
    {
Intent intent = getPackageManager().getLaunchIntentForPackage("cc.blynk");
if (intent != null) {
    // We found the activity now start the activity
    intent.addFlags(Intent.FLAG_ACTIVITY_NEW_TASK);
    startActivity(intent);
} else {
    // Bring user to the market or let them choose an app?
    intent = new Intent(Intent.ACTION_VIEW);
    intent.addFlags(Intent.FLAG_ACTIVITY_NEW_TASK);
    intent.setData(Uri.parse("market://details?id=" + "com.package.name"));
    startActivity(intent);
}
}
}
}

```

MywebviewClient.java

```

package app.nomitha.com.webview;

import android.webkit.WebResourceRequest;

import android.webkit.WebView;

import android.webkit.WebViewClient;

public class MyWebViewClient extends WebViewClient {

    @Override

    public boolean shouldOverrideUrlLoading(WebView view, WebResourceRequest request) {

return false;

    }

}

```

manifest.xml

```

<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"

package="app.nomitha.com.webview">

<application

android:allowBackup="true"

android:icon="@mipmap/ic_launcher"

android:label="@string/app_name"

android:roundIcon="@mipmap/ic_launcher_round"

android:supportsRtl="true"

android:theme="@style/AppTheme">

<activity android:name=".MainActivity">

<intent-filter>

```



```

        <action android:name="android.intent.action.MAIN" />

        <category android:name="android.intent.category.LAUNCHER" />

    </intent-filter>

</activity>

</application>

<uses-permission android:name="android.permission.INTERNET" />

</manifest>

```

layout_main.xml

```

<?xml version="1.0" encoding="utf-8"?>
<RelativeLayout xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:app="http://schemas.android.com/apk/res-auto"
    xmlns:tools="http://schemas.android.com/tools"

    android:layout_width="match_parent"
    android:layout_height="match_parent"
    tools:context=".MainActivity">

    <WebView

        android:id="@+id/mywebview"

        android:layout_width="match_parent"

        android:layout_height="381dp"

        android:layout_alignParentTop="true" />

    <Button

        android:id="@+id/button"

        android:layout_width="194dp"

        android:layout_height="71dp"

        android:layout_alignParentBottom="true"

        android:layout_centerHorizontal="true"

        android:layout_marginBottom="67dp"

        android:onClick="launch"

        android:text="Turn Motor ON/OFF" />

</RelativeLayout>

```

6.1.4 Server side Scripting

add.php

```

<?php

$temp=$_REQUEST['temp'];

$hum=$_REQUEST['hum'];

$volt=$_REQUEST['volt'];

include_once('db.php');

$sql="insert into data(temp,hum,volt,udate,utime) values($temp,$hum,$volt,curdate(),curtime())";
$res=execute( $sql);

echo "saved";

?>

```

Above script gets invoked by the ESP32 connected to Lora transmitter, this script reads sensor data such as humidity, temperature, voltage, current and populates the information with table called data, all information is saved in the form of fields in tuple. */

Db.php

```

<?php

function execute( $sql )

{

$conn=mysqli_connect( 'localhost', 'root', '', 'project' );

if( !$conn )

{

die( mysqli_connect_error() );

}

$res=$conn->query( $sql );

if( !$res )

{

die( mysqli_error( $conn ) );}

return( $res );

}

?>

```

Above script finds very useful in this project to do database transaction's, it has a function called execute () which takes SQL i.e., the query to be executed as parameter, executes the parameter and returns the result. In the proposed prototype it is used to invoke insert into, select statement.

Readings.php

```

<!DOCTYPE html>

<html lang="en">

<head>

<meta charset="utf-8">

```

```

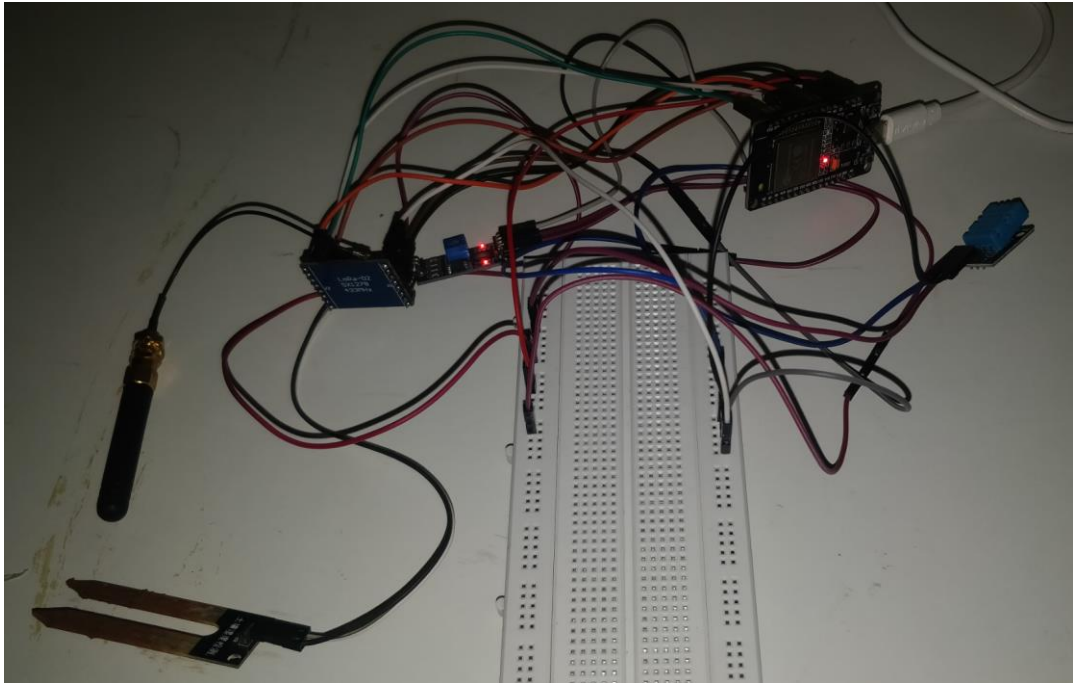
<meta http-equiv="X-UA-Compatible" content="IE=edge">
<meta name="viewport" content="width=device-width, initial-scale=1">
<!-- The above 3 meta tags *must* come first in the head; any other head content must come *after* these tags -->
<title>Bootstrap 101 Template</title>
<!-- Bootstrap -->
<link href="css/bootstrap.min.css" rel="stylesheet">
<meta http-equiv="refresh" content="3">
</head>
<?php
include_once('db.php');
$sql="select * from data order by curtime desc limit 10";
$res=execute( $sql );
?>
<table class="table table-bordered" >
<tr><th>Temparature</th><th>Humidity</th><th>voltage</th><th>Date</th><th>Time</th>
</tr>
<?php
while( $row=$res->fetch_object() )
{
?>
<tr>
<td><?php echo $row->temp ?></td>
<td><?php echo $row->hum ?></td>
<td><?php echo $row->volt ?></td>
<td><?php echo $row->curdate ?></td>
<td><?php echo $row->curtime ?></td>
</tr>
<?php } ?>
</table>

```

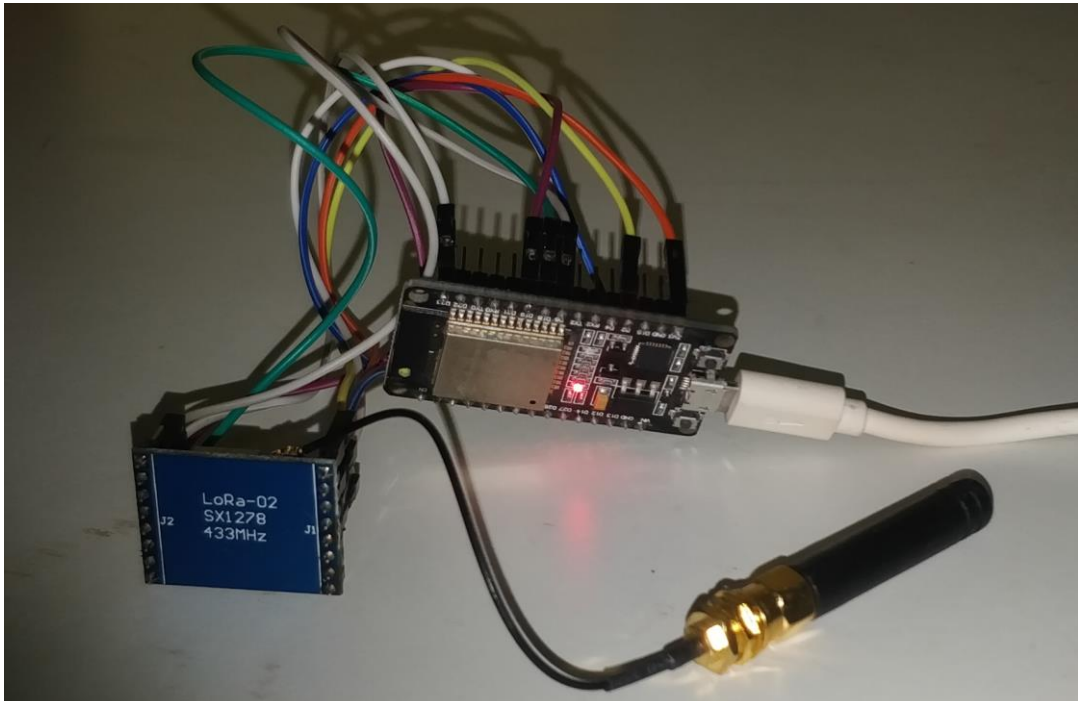
/*Above script gets invoked by the android app, this script displays various parameter values such as temperature, humidity, voltage, current which is being saved in the database by base station module, it makes use of db.php file to run select statement. To display information bootstrap frame work will be used. */

6.2 Screenshots

1. LoRa sending kit which shows the interconnection between LoRa device, ESP 32, DHT11 sensor and soil moisture sensor.



2. LoRa receiving kit which shows LoRa device connected with ESP32 device.



3. Serial monitor screen showing the packets sent by LoRa sender.

```
COM5
Content-Length: 9
Connection: close
Content-Type: text/html; charset=UTF-8

saved
closing connection

Sending packet: 88
Moisture = 4095
Temperature = 33.10, Humidity=56.00
Requesting URL: http://192.168.225.44:80/d/add.php?temp=33.10&hum=56.00&moist=4095
HTTP/1.1 200 OK
Date: Thu, 06 Jun 2019 13:57:11 GMT
Server: Apache/2.4.29 (Win32) OpenSSL/1.1.0g PHP/7.2.0
X-Powered-By: PHP/7.2.0
Content-Length: 9
Connection: close
Content-Type: text/html; charset=UTF-8

saved
closing connection

Sending packet: 89
Moisture = 4095
Temperature = nan, Humidity=nan

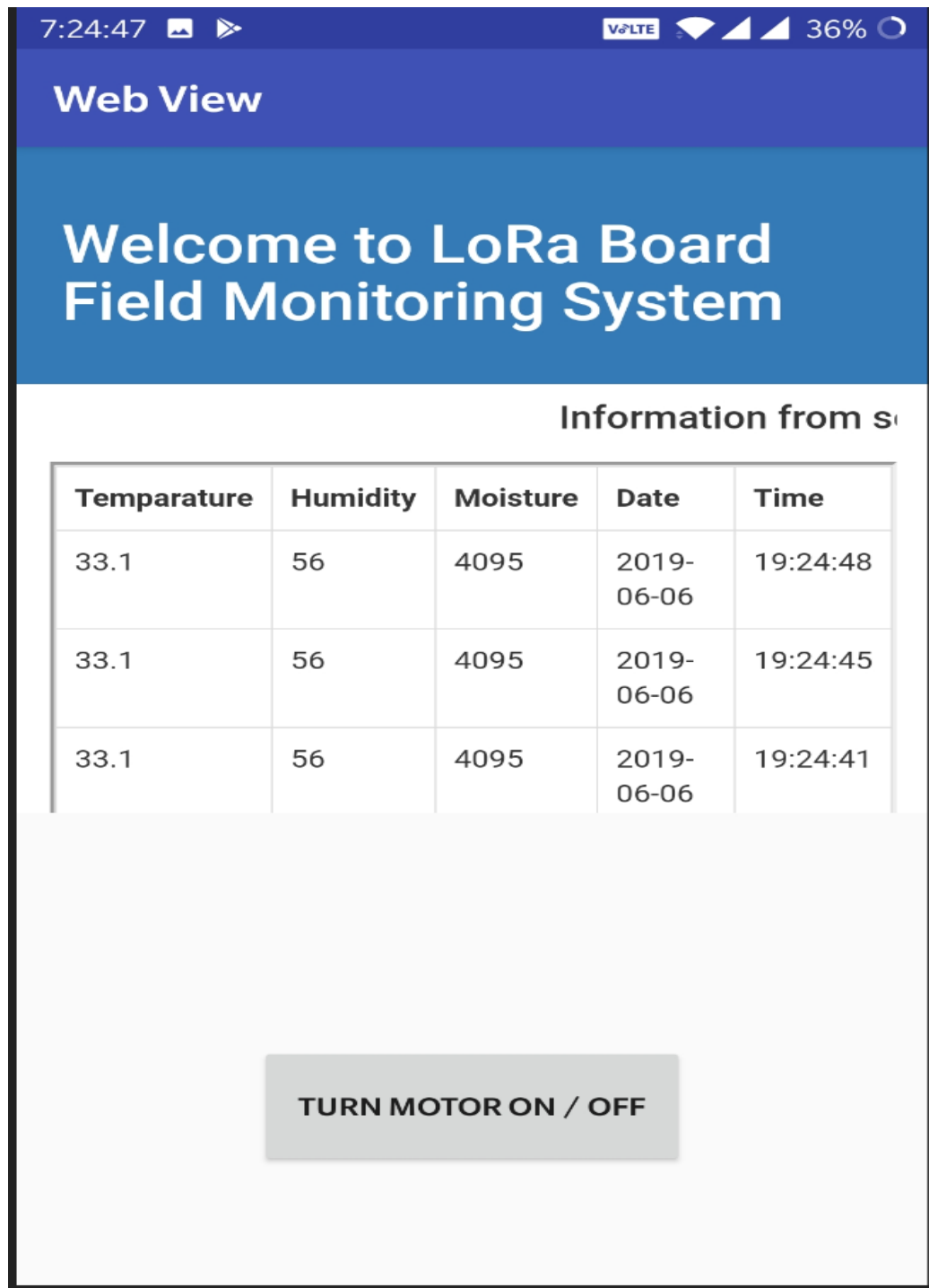
Autoscroll Both NL & CR 115200 baud Clear output
```

4. Serial monitor screen showing the packets received by LoRa device.

```
COM3
Received packet '237Moisture value=4095, Humidity value=56.00, Temperature value=33.30' with RSSI -43
Received packet '258Moisture value=4095, Humidity value=56.00, Temperature value=33.30' with RSSI -44
Received packet '259Moisture value=4095, Humidity value=56.00, Temperature value=33.30' with RSSI -44
Received packet '260Moisture value=4095, Humidity value=56.00, Temperature value=33.30' with RSSI -43
Received packet '261Moisture value=4095, Humidity value=56.00, Temperature value=33.30' with RSSI -45
Received packet '262Moisture value=4095, Humidity value=56.00, Temperature value=33.30' with RSSI -45
Received packet '263Moisture value=4095, Humidity value=56.00, Temperature value=33.30' with RSSI -46
Received packet '264Moisture value=4095, Humidity value=56.00, Temperature value=33.30' with RSSI -46
Received packet '265Moisture value=4095, Humidity value=56.00, Temperature value=33.30' with RSSI -46
Received packet '266Moisture value=4095, Humidity value=56.00, Temperature value=33.30' with RSSI -46
Received packet '267Moisture value=4095, Humidity value=56.00, Temperature value=33.30' with RSSI -46
Received packet '268Moisture value=4095, Humidity value=56.00, Temperature value=33.30' with RSSI -46
Received packet '269Moisture value=4095, Humidity value=56.00, Temperature value=33.30' with RSSI -45
Received packet '270Moisture value=4095, Humidity value=56.00, Temperature value=33.30' with RSSI -46
Received packet '271Moisture value=4095, Humidity value=56.00, Temperature value=33.30' with RSSI -46
Received packet '272Moisture value=4095, Humidity value=56.00, Temperature value=33.30' with RSSI -46
Received packet '273Moisture value=4095, Humidity value=56.00, Temperature value=33.30' with RSSI -45
Received packet '274Moisture value=4095, Humidity value=56.00, Temperature value=33.30' with RSSI -44
Received packet '275Moisture value=4095, Humidity value=56.00, Temperature value=33.30' with RSSI -44
Received packet '276Moisture value=4095, Humidity value=56.00, Temperature value=33.30' with RSSI -46
Received packet '277Moisture value=4095, Humidity value=nan, Temperature value=nan' with RSSI -47
Received packet '278Moisture value=4095, Humidity value=56.00, Temperature value=33.30' with RSSI -46
Received packet '279Moisture value=4095, Humidity value=56.00, Temperature value=33.30' with RSSI -46
Received packet '280Moisture value=4095, Humidity value=56.00, Temperature value=33.30' with RSSI -46
Received packet '281Moisture value=4095, Humidity value=56.00, Temperature value=33.30' with RSSI -45
Received packet '282Moisture value=4095, Humidity value=56.00, Temperature value=33.30' with RSSI -46
Received packet '283Moisture value=4095, Humidity value=56.00, Temperature value=33.30' with RSSI -45
Received packet '284Moisture value=4095, Humidity value=56.00, Temperature value=33.30' with RSSI -45
Received packet '102Moisture value=4095, Humidity value=55.00, Temperature value=33.20' with RSSI -40
Received packet '103Moisture value=4095, Humidity value=55.00, Temperature value=33.10' with RSSI -38
Received packet '104Moisture value=4095, Humidity value=55.00, Temperature value=33.20' with RSSI -38
Received packet '105Moisture value=4095, Humidity value=55.00, Temperature value=33.20' with RSSI -37
Received packet '106Moisture value=4095, Humidity value=55.00, Temperature value=33.20' with RSSI -38
Received packet '107Moisture value=4095, Humidity value=nan, Temperature value=nan' with RSSI -38
Received packet '108Moisture value=4095, Humidity value=55.00, Temperature value=33.20' with RSSI -37
Received packet '109Moisture value=4095, Humidity value=55.00, Temperature value=33.20' with RSSI -42
Received packet '110Moisture value=4095, Humidity value=55.00, Temperature value=33.10' with RSSI -42
Received packet '111Moisture value=4095, Humidity value=55.00, Temperature value=33.20' with RSSI -42

Autoscroll Show timestamp Newline 115200 baud Clear output
Type here to search 6:58 AM 6/6/2019
```

5. Android application screen which includes a button to “Turn ON/OFF the motor”.



6. Blynk application screen which gets opened up when on clicking the button in Android application.

7:24:39

VOLTE

36%



LoRa_Project



BUTTON



Model being created

Model got created

Ph	Carbon	Sand	Silt	Clay	Distance	Crops
5.82	0.88	53	22	25	3.061	corn
5.82	0.88	53	22	25	3.061	corn
6.41	1.58	53	22	25	3.126	rice
6.41	1.58	53	22	25	3.126	barley
6.41	1.58	53	22	25	3.126	rice
6.41	1.58	53	22	25	3.126	barley

Matrix being created it includes 3 nearest neighbours

Matrix got created

Ph	Carbon	Sand	Silt	Clay	Distance	Crops
5.82	0.88	53	22	25	3.061	corn
5.82	0.88	53	22	25	3.061	corn
6.41	1.58	53	22	25	3.126	rice

Voting table being created and crop being recommended

Voting Table

Crops	Count
corn	2
rice	1

Recomended crop is corn

CHAPTER 7

CONCLUSION

The project is aimed at developing an useful product to society by using recent trends in technology i.e IoT and Machine learning. Here an advanced wireless communication medium i.e LoRa is used to enable communication between base stations span over the field, sensors such as DHT11, soil moisture, soil ph and ec sensor are interfaced with device called ESP32, same module is associated with LoRa chips too, the device is programmed in such a way that it fetches soil parameters via sensors and sends through LoRa enables transmitter, which operates at open frequency band, further the receiver which is located at far flung place is interfaced with LoRa receiver receives information packets and dumps all the info to centralized database using server side scripting. The concept of LoRa helps to develop wireless communication channel which operates at low power and reaches maximum distance. This technology has many advantages compared to existing communication medium.

The data containing various parameters such as Ph, Ec, Sand, Silt from wireless sensor network is processed using KNN algorithm and crop to be reared is recommended

CHAPTER 8

FUTURE ENHANCEMENTS

The proposed concept what I have developed in this project could be improved further by adding following features to it

1. Number sensors used could be increased to fetch more soil parameters so that more accurate results could be predicated
2. Here in the present system we have analysed soil parameters using KNN algorithm, the obtained result could be analysed with other algorithms so that accuracy of the result could be improved
3. By increasing volume of dataset accuracy of the result could be increased.

APPENDIX- LORA BASED WIRELESS SENSOR NETWORK FOR SMART AGRICULTURE

RESEARCH PAPER ACCEPTED IN SOLID STATE TECHNOLOGY(SCOPUS)

LoRa Based Wireless Sensor Network for Smart Agriculture

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Abstract-

The principle goal of this paper is to give quality harvest development method in a predefined standard for example utilizing LoRa innovation. A system contains numerous hubs and every hub will be conveyed in a predetermined and predefined place. In this few hubs, one hub goes about as the organizer that is associated with the concentrated machine. Every hub comprises of a processor for example Arduino, sensors are used for estimating the accompanying parameters soil dampness, mugginess, temperature and light power and a LoRa which goes about as the end gadget.

Keywords: LoRa Transmitter and receiver, Sensors, Server, database.

I. INTRODUCTION

Our nation is agribusinessbased country where half of Indian populace has cultivating as their essential occupation or side business. Present day cultivating can be accomplished by including new ideas, for example, Internet of Things (IoT), Wireless Sensor Networks (WSN) and Precision Agriculture (PA)[5]. Precision agriculture is portraying as the condition of workmanship and study of receiving cutting edge innovation to expand the yield development. Horticultural data sources, for example, showering, excrement, bug sprays, and so on are connected in exact amounts as controlled by displaying of yield development courses of action to misrepresent the plant field and to reduce the effect on nature.

The assurance of the harvests is basic. So, there is a requirement for checking of the information and that information ought to be genuine. So as to give moment answer for the yields the information ought to be gathered in a savvy way yet not by manual strategies. So, to accomplish this we need to utilize remote sensor organize. As of now wireless sensor network is received by numerous applications like water quality administration, information gathering, wellbeing checking and so on.

Wireless Sensor Network is a rising trend setting innovation that helps the advancement of exactness horticulture. WSN contains sensors, RF modules (radio recurrence modules), microcontrollers to process the information, battery, base station to transmit the information. Ongoing patterns and progressions in WSN innovation have cut the way for the improvement of less expense. These sensor hubs can be made to speak with other sensor hubs in the system to trade the fundamental information. The different sensors which are utilized are soil dampness sensor and temperature sensor. As India devours 80% of all out accessible water assets for water system reason, we are in a circumstance where water utilization must be diminished utilizing progressed logical procedures to evade this we can utilize soil dampness sensor as an answer. The fundamental attributes of WSN is self-sorting out and selfreuperating. When the hubs are conveyed and a system is shaped at that point, the information will be naturally transmitted with no order or control. On the off chance that any gadget in the system breakdown, at that point the system won't be harmed rather it will take another working way and achieves the goal. So, any harms or breaking down of a solitary hub doesn't influence the entire system.

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